Read New Hydrocarbon Story

CHEMISTRY

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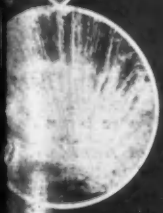

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25¢

Twenty-first Year

A SCIENCE SERVICE PUBLICATION

Genius or Luck?

ARE THE GERMANS the world's greatest chemists, or just its unluckiest people? If they had had the luck to find oil within their political boundaries, any one of a number of factors in recent world history might have been different. If they had had more gas for pleasure driving they might have gotten better acquainted with their neighbors instead of making the schizoid retreat that was their prelude to war.

But if the Germans had had such luck, they might not have been driven by hard necessity to make what use they could of substitute materials. Coal and acetylene would have remained rather old-fashioned fuels, and German chemists would have exercised their talents on other problems. They might not have gotten around to cyclo-octatetraene.

Synthetic rubber, too, might have remained a small-scale laboratory experiment instead of a grim necessity. Styrene and butadiene would have interested only candidates for a Ph.D.

It is idle to speculate too long on what might have happened — *if* —. It is still more idle to try to say whether a new discovery is good or bad. Since it is in existence, it is a factor to be coped with from now on. How we use it is up to us.

The substitute chemicals from unlucky Germany are now part of the world's resources, and so are the talents of the men who devised them. How can we best use them for the welfare of mankind?

If Germany's scientists produced well under hardship and necessity, must we make life all but unbearable for all scientists to stimulate still more latent talent? Or should we reward the Germans for past accomplishments by supporting them in luxury while we ignore in our own country young candidates for scientific careers whose abilities are sorely needed for the years just ahead?

For the answers to questions like these, we are going to need whatever of genius we can command, and plenty of luck beside.

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***Consulting Editor*: PAULINE BEERY MACK (Editor 1927-1944)**

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▶ CYCLO-OCTATETRAENE, *the new hydrocarbon, is in the sealed tube held by Dr. Frederick D. Rossini of the National Bureau of Standards. On the table in front of him are models of the three possible ring forms which its molecule might take, the Tub, the Crown and the Chair.*

New Cyclic Hydrocarbon

by HELEN M. DAVIS

▶ A CHEMICAL treasure hunt combining the thrills of mystery, romance and gambling for high stakes has developed in chemical laboratories all over the world as a result of privations the Germans had to undergo during the recent war.

The mystery centers around a new chemical, cyclo-octa-tetra-ene, a pale yellowish liquid which may open the door to new plastics, new medicines, new materials of every sort by the thousand, or which, just possibly, may not really exist at all. That is where the gambler's chance comes in. As the touch of romance, the original sample of the new chemical was made from

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an alkaloid extracted from the pomegranate tree.

Back in 1911 the German chemist Willstätter had reported making cyclo-octa-tetra-ene from another substance, pseudo-pelletierine, which, in turn, he had gotten from pomegranate bark. The useful products, camphor and quinine, obtained from tropical trees, had doubtless suggested the original research. The unusual properties of the oily liquid he obtained made him study it further, and he and his associates published during the next two years all that was known about it until 1939.

In the meantime, chemists had been engaged on the much more urgent problem of making artificial rubber. They had progressed far enough to know that one of the important ingredients of artificial rubber is styrene. In 1939 several chemists, working independently, reported that some of the properties characteristic of styrene are identical with those that Willstätter had reported for his cyclo-octatetraene. Some believed that the earlier chemical was nothing but styrene. Others thought it might have broken down to form the rubber chemical.

The problem interests organic chemists because cyclo-octatetraene, if it exists at all, has the carbon atoms of its molecule arranged in an entirely new pattern. There is interest in whether such an arrangement can exist, whether, if it can be formed, the strain on the forces holding it together might make it fly apart in some unknown, explosive way, and what sort of compounds it will make if it turns out to be chemically stable. At this point war overtook research.

As is well known, Germany has not succeeded, in two world wars, in bludgeoning her way into control of the major oil fields of Europe. Her lack of petroleum and its products forced her chemists to develop substitutes from coal. Distillation of coal yielded acetylene in quantity, and frome acetylene they made many chemicals whose raw materials, in this country, are derived from oil.

Acetylene was once familiar as the fuel for automobile and bicycle lamps. It may be remembered for its sooty flame. The soot comes from the large percentage of carbon in its molecules. The chemist calls it a highly unsaturated compound, ready to take up more oxygen very easily. Its readiness to combine makes many of the chemicals derived from it dangerously explosive.

Forced by necessity to make the most of acetylene, which they had, German chemists learned a great deal about handling it and synthesizing other materials from it. One of the substances we have now learned that they made turns out to be Willstätter's cyclo-octatetraene. It was synthesized by J. Walter Reppe of I. G. Farbenindustrie by modern methods of polymerization by the aid of catalysts, much more simply than by the many-step process from pomegranate bark. The Technical Information Service of the Department of Commerce has brought to this country a description of the process and samples of the material itself.

The National Bureau of Standards at Washington is making measurements of some of the fundamental constants of this new compound. Dr. Frederick D. Rossini, Dr. Edward J. Prosen and Dr. Walter H. Johnson of

▶ CONTROLS *on the calorimeter are adjusted by Dr. Edward J. Prosen, National Bureau of Standards, who makes measurements of the heat of combustion of the new chemical. Inside the apparatus a weighed sample of cyclo-octatetraene is burned in pure oxygen.*

its Thermochemical Laboratory have just announced the results of their measurements of the heat of combustion and the heat of formation of the new material.

They conclude that, from the energies measured, cyclo-octatetraene is definitely less stable than styrene. Since it will be used as an intermediate in the manufacture of other chemicals, this instability is interesting to chemists. Compounds of it with other atomic groups may be more stable than the parent substance. They may even, in the opinion of Dr. Rossini, lead to compounds impossible of formation from materials now known.

Another center of research investigating the material is the Chemistry Department of the Massachusetts Institute of Technology. Its director, Dr. Arthur C. Cope, reports that his staff has repeated the synthesis by the old method and established the fact that

the new material is identical with the compound Willstätter got.

In regard to the German material, Dr. Cope explains: "A catalytic synthesis of cycloöctatetraene (C_8H_8) from acetylene was developed at the Ludwigshaven Laboratories of the I. G. Farbenindustrie during the war. This synthesis consisted in the polymerization of four molecules of acetylene over a nickel cyanide catalyst in tetrahydrofuran as a solvent at 15-18 atmospheres pressure at approximately 70° C. The product was the straw yellow, very reactive hydrocarbon cycloöctatetraene.

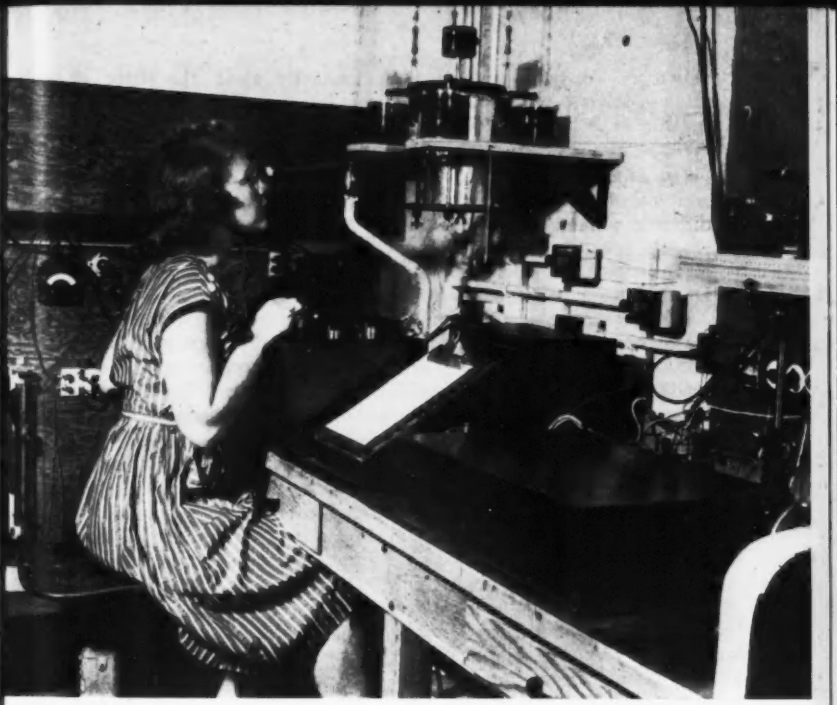
"Before development of this catalytic synthesis, cyclo-octatetraene had been prepared only by a long and difficult synthesis from the rare pomegranate bark alkaloid, pseudo-pelletierine. This original synthesis was performed by Willstätter, Waser and Heidelberger, in 1911-1913. Their synthesis had not been repeated until this year, probably in part due to the unavailability of pseudopelletierine and in part to the difficulty of the synthesis. In the intervening years many chemists had come to doubt the validity of the Willstätter synthesis. Some of the properties of the Willstätter product resembled corresponding properties of the isomeric aromatic hydrocarbon, styrene. In addition, behavior of certain model compounds resembling intermediates in the Willstätter synthesis was interpreted as casting doubt upon the ability of the original synthetic route to yield cycloöctatetraene, rather than isomeric hydrocarbons.

"Cycloöctatetraene has been of very considerable theoretical interest ever since the development of the Kekulé formula for benzene. Its structure comprises an 8-membered ring with four conjugated double bonds, and chemists have been interested in determining whether a compound with such a structure would be a stable compound with aromatic properties like benzene, or whether such a structure would be reactive like open-chain polyenes, such as butadiene.

"The German synthesis of cycloöctatetraene from acetylene and correspondence in properties of the catalytic product with the Willstätter product made it seem very likely that the Willstätter synthesis was in fact correct. In this laboratory," continues Dr. Cope, "we have established the validity of the Willstätter synthesis beyond question by repetition of the synthesis beginning with synthetic pseudopelletierine. The product obtained was identical with a sample of cycloöctatetraene prepared catalytically from acetylene."

Dr. Cope's laboratory has, indeed, gone the Germans one better and prepared the novel chemical by another method from a different material, the open-chain diene, chloroprene. His description of the new process is in process of publication.

"Cycloöctatetraene is not being prepared commercially in this country," says Dr. Cope. "If it were to be prepared, the process used presumably would be essentially the one developed by the I. G. laboratories. The compound may prove to be of practical importance as a chemical intermediate in the synthesis of several other compounds, including suberic acid and terephthalic acid (polymer intermediates), and phenylacetaldehyde. The manufacture of chemicals from



▶ PRECISE READINGS *of temperature inside the distant calorimeter are being read by Miss Florence Yenchius at the Bureau of Standards, as cyclo-octatetraene is burned to carbon dioxide and water. The magnification used in these determinations is equivalent to stretching one degree on the ordinary thermometer to the length of thiry feet.*

acetylene is a large-scale industry in this country, and it seems reasonable to expect that companies engaged in this business will examine the economics of the cycloöctatetraene synthesis closely and consider its production if the compounds derived from it appear to be salable in a quantity and at a price which would justify development of the catalytic synthesis."

Another research center which has been working with the mystery chemical is the Institute of Polymer Research of the Polytechnic Institute of Brooklyn, N. Y. Its Director is Dr. H. Mark, who outlines the work under way there as follows:—

(a) Preparation of cycloöctatetraene (COT) by various methods; study of the mechanism of formation of COT by the polymeri-

zation of acetylene; influence of catalyst, solvent, pressure, and temperature (Dr. Overberger, Mr. Klotz).

(b) Study of the dimerization and polymerization of COT in different solvents and with different catalysts; characterization of the polymers obtained (Dr. Overberger, Dr. Bergmann).

(c) Preparation of C_8D_8 and of the higher homologs of COT, particularly $C_{10}H_{10}$ and $C_{12}H_{12}$.

(d) X-ray investigation of COT, of its polymers and of the higher homologs (Professor Fankuchen, Dr. Kaufman).

"As far as I know," continues Dr. Mark, "there is no commercial process in operation to make COT in large units. Everyone is still working on a laboratory scale. I don't think COT itself will be of great practical value, but it is a *most important* new material for preparing a large number of very interesting new organic compounds which have great potential value for the plastics, rubber, plasticizer, dyestuff and pharmaceutical field. It would require a monograph of 50 pages to enumerate all these compounds."

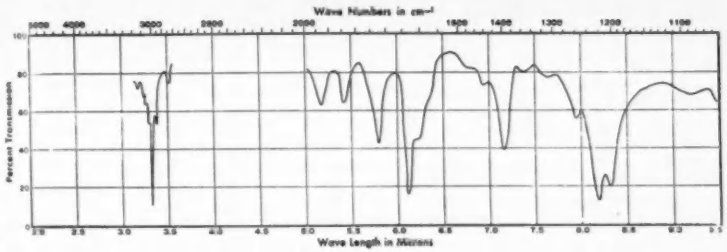
Since Willstätter's original studies of COT, much has been learned about the way chemical compounds are formed and the forces that hold them together. Measurements made by X-ray diffraction and with the electron microscope give the position of the atoms in relation to each other. Interpretation of data by use of wave-mechanics formulas and the quantum theory limits the number of possible arrangements of these atoms. As a result, chemists now speak with great certainty about the shape of molecules.

Some organic compounds are formed of long chains of atoms open at the ends for addition of other chemical groups. Compounds of the benzene series, on the other hand, are made of six carbon atoms joined in a closed ring. This is a remarkably strong structure, surviving a lot of chemical rough treatment. Chemists are naturally curious to know what kind of structure the molecule of cycloöctatetraene has in the light of the newer methods of measurement.

The belief of older chemists is shown by the name of the compound. The -ene at the end of the name refers to what chemists call a double bond between two carbon atoms, and the -tetra- just before it means that there are four double bonds in each molecule. Octa- means that there are eight carbon atoms altogether, and cyclo- means that they are joined in a ring. The theory, then, was that the eight carbon atoms of the new compound join to form a ring like the six in the benzene ring, with single and double bonds alternately between them.

Modern chemists, however, are not content to write the formula so unless their measurements confirm the theory. In the case of COT these measurements say, "No." While the angles between the carbon atoms of benzene allow a model representing the molecule to lie flat on the table, a similar model using the angles found in the new compound refuses to stay in one plane, and the ring has to be allowed to twist itself into a three-dimensional puckered shape.

By working with mathematical



▶ DISTINCTIVE *as a fingerprint, this infrared spectrogram of cyclo-octatetraene shows by the sharp dip at wave-length 3.3 (approximately) that the substance is a hydrocarbon. The other dips and quavers show how it differs from all the thousands of other known hydrocarbons. This is part of the record made at the Spectroscopy Laboratory of the Massachusetts Institute of Technology. It appears as No. 595 in the catalog of infrared spectrograms of the American Petroleum Institute's Research Project 44 at the National Bureau of Standards.*

equations and playing with models, chemists have learned that there are just three possible configurations of the cyclo-octatetraene molecule that will satisfy the known measurements of its molecular dimensions. They know that the carbon atoms are quite symmetrical to each other, that while there is a "pucker" there is no one-sided "bulge."

The three forms possible they describe as the "tub," the "crown" and the "chair." Unromantic as it may seem, the "tub" form seems to be the one that fits the facts best. There seems definitely to be but one form, not a mixture of two or three.

A report on the molecular shape was made by Dr. Mark's group at the recent International Chemical Congress in London, and a communication on the same subject has just appeared in the British journal "Nature" from Dr. O. Bastiansen and Dr. O. Hassel of the University of Oslo and Dr. A. Langseth of the University of Copenhagen.

To understand the excitement in research circles over the possibilities offered by the new chemical, it is necessary to appreciate benzene and the role it plays in the world of materials. Without the benzene ring, we would have, among other inconveniences, no dyes and no perfumes. Very likely we would have to do without the comforts of the alkaloids, from nicotine to morphine.

The benzene ring is formed from six carbon atoms, each accompanied by an atom of hydrogen: C_6H_6. One or more of the hydrogen atoms can be replaced by atoms of other kinds, especially by the so-called organic radicals. These are groups of atoms, usually carbon, hydrogen and oxygen, which stick together and act as a single entity. Constellations of such organic radicals make up thousands of chemical compounds.

Given, now, cyclo-öctatetraene, the new ring structure, C_8H_8, and the chemists see the possibility of another set of compounds paralleling those of benzene. They are sniffing at the German liquid, because pleasant odors (a welcome change from some chemicals) are characteristic of benzene derivatives. Compounds containing the benzene ring are known as the aromatic series. Is aromatic scent related to carbon ring structure? What will the new compounds smell like?

Then there is the possibility of dyes from the new compound. Color is a rare and precious quality among chemicals. Most of them are colorless, or white powders which reflect all light waves equally well. Only occasionally does one occur whose internal structure is attuned to absorbing particular wave-lengths and sending the rest of the light back to the eye of the observer, to give the sensation of color. A chemical which will do that to light and at the same time stick to cloth is a dye. Experiments to find whether the new ring chemical will produce dyes will no doubt be tried eagerly when enough of the material to work with has been made.

When it comes to medicines, the prospect of the new series of compounds is dizzying. So much new knowledge along this line is pouring out of research laboratories already that the paths leading to rich new fields seem limitless.

Then there are the plastics. Certain big organic molecules, under the right conditions, have what amounts to a hunger for gobbling up such material as they are made of, and growing as long as the supply lasts. This property of polymerization gave us synthetic rubber from butadiene and styrene. And here the chemist feels on safer footing, for butadiene has some structural resemblance to COT and styrene is in so many ways like COT that, as we have seen, they have been mistaken for each other. Even if the COT ring proves unstable there is the chance that the energy that tears it apart may be useful in building its fragments into new polymers.

On the Back Cover

➤ WEIGHED AS *carbon dioxide, which has been absorbed by appropriate chemicals, cyclo-octatetraene gives up the secrets of its structure to the searching eyes of scientists. Possibility that the new hydrocarbon may be the start of a new line of products as varied and useful as the benzene derivatives has chemists agog to learn fundamental data about the unstable yellow oil.*

All photographs in this series are by Fremont Davis, Science Service Staff Photographer.

Plutonium Pile for Power

➤ THE NEW KIND of atomic energy machine or "pile" announced recently at Los Alamos is essentially an atomic bomb that can be kept under strict control and made to release its energy slowly.

The "fast reactor," as it is known, uses the same kind of fast neutrons (moving thousands of miles per second) that set up the very speedy chain of fissions of plutonium atoms in the explosive bomb. Neutrons are fundamental particles of matter that can smack into the hearts of fissionable atoms and tear them asunder.

For the first time, too, a controlled atomic energy source uses the man-made bomb element, plutonium, instead of the uranium that occurs in nature.

While the new "fast reactor" is not in itself a practical source of power in its present form, it does explain why those who have known what has been going on were not too enthusiastic about the power production possibilities of the older type of atomic piles which use the slow neutrons.

Dr. Norris E. Bradbury, scientific director of the Los Alamos Scientific Laboratory, in announcing that the new atomic energy plant has been operating since last November, called it "another step" toward finding the best kind of atomic power plant.

The immediate use of the new atomic pile is to study under controlled conditions highly concentrated, intense and very high velocity neutrons, hitherto only obtained from the actual explosion of an atomic bomb.

The similarity of the new reactor and the actual atomic bomb is emphasized by the fact that all other reactors have their nuclear fuel mixed with some diluting substance, such as very pure graphite or heavy water, which slows down the neutrons. The new pile has no such material in it. It is also known that the bomb also has no such extraneous material in it.

Development of the fast reactor now announced presumably cost one human life, that of Dr. Louis Slotin, who was victim of a radiation accident at Los Alamos in May, 1946. Dr. Slotin is understood to have received a fatal dose of radiation when he separated with bare hands masses of fissionable material that were beginning to shine with a blue glow, a preliminary to what probably would have been a disastrous atomic explosion. His self-sacrifice probably saved the lives of fellow scientists and the experimental set-up that brought forth the new atomic device.

A husband-and-wife team of physicists, Drs. David B. and Jane Hamilton Hall, is in charge of the fast reactor and its various experiments, while the engineer in charge is Robert I. Howes.

Fission of Lighter Elements

➤ FISSION, originally confined to the heaviest elements such as uranium

and plutonium, has been caused in atomic nuclei as light as tantalum, element 73, by ultra-high energy atomic bullets fired by the giant University of California cyclotron.

Splitting of nuclei in the fission reaction was achieved with platinum, lead, bismuth, and thallium, as well as with tantalum, a group of Berkeley scientists reported in *The Physical Review*.

The scientists add that elements between tantalum and bismuth, the heaviest of the five, probably could be "fissioned," but that no efforts have been made to do so yet. These intermediate elements include mercury, gold, iridium, osmium, rhenium, and tungsten.

The group of scientists reporting the research include Dr. Isadore Perlman, R. H. Goeckermann, Dr. D. H. Templeton, and Dr. J. J. Howland. The research was sponsored by the Atomic Energy Commission.

Dr. Perlman stated that ultra-high energy fission with deuterons, neutrons and alpha particles differs from the slow neutron fission which causes an atomic bomb to explode. There is no chain reaction, he explained, therefore the high energy fission reaction in these elements is not applicable to making a bomb or to atomic energy.

The scientist added that such research is invaluable in yielding new fundamental information about the atomic nucleus.

In addition to the absence of a chain reaction in high energy fission, this type of fission differs from slow neutron fission in other ways. Some stable, non-radioactive isotopes are found as primary fission products. Nuclei fissioned by high energy particles tend to split more evenly, where slow neutron fission produces a less even split. Some products not found in slow neutron fission are produced in the heavier elements. There is a decreasing incidence of fission in lighter elements with high energy particles.

Sun's "Heatshine" Hotter

➤ ASTRONOMERS have trained the eye of the wartime snooperscope upon the infra-red "heatshine" of the sun and discovered that the sun is producing much more energy than can be expected from the extent of its supposed temperature.

Probably the most important astronomical advance of the year, the American Astronomical Society meeting at Evanston, Ill. heard a group of scientists from the University of Michigan's McMath-Hulbert Observatory tell how they had penetrated a region of the sun's radiation never before adequately explored.

They used a sky-observing variation of the famous snooperscope, sniperscope and infra-red signaling devices that GIs used in spotting unsuspecting Japs. This consists of a lead sulfide photocell sensitive to heat or infra-red radiation. The cell used in solar observation has a hundred times the sensitivity of the best heat-measuring thermocouple used by astronomers heretofore. With this solar snooperscope, the astronomers are able to chart in detail the deep infra-red solar spectrum that is unreachable with ordinary photographic plates sensitive to visible light.

There must be some way in which

the sun is producing a great deal more energy than one would expect from its apparent surface temperature, Dr. Leo Goldberg of the University of Michigan told the astronomers, because there is a startling discrepancy observed between the infra-red spectrum lines caused by iron atoms and the prediction from currently accepted theory. The iron atoms in the sun's lower atmosphere could not produce the snooperscope effect observed if they were at a mere temperature of 4,800 degrees absolute temperature now assigned them. Estimates of million-degree temperatures in the sun's corona fit in with the new observations.

Since the sun's heat is produced by a cycle of atomic energy involving helium, hydrogen, carbon and other light elements, the new observations will probably give rise to new speculation concerning this solar conversion of mass into energy.

Oxygen and water vapor in the earth's atmosphere blanket the earth and prevent visual observation of the sun's spectrum in the infra-red region. Beginning at about 11,000 Angstroms (units in which radiation is measured) and extending to 15,000 Angstroms, the solar spectrum consists mainly of absorption bands of molecules in the earth's atmosphere.

Dr. Arthur Adel, of the Michigan team and pioneer in infra-red observation, reported the identification of new atomic lines between 15,000 and 16,000 Angstroms which cannot be duplicated here on earth.

Dr. Robert R. McMath, director of the McMath-Hulbert Observatory which has two towers continuously observing the sun, and Dr. Orren C. Mohler told how new equipment, using mirrors exclusively instead of lenses, will extend the infra-red observations out to about 40,000 Angstroms this winter.

The lead sulfide cell developed by Dr. R. J. Cashman of the Northwestern Technological Institute has its range limited now to about 20,000 Angstroms by having to work with radiation that passes through glass which screens out some of the heat bands.

Particles Turn to Hydrogen

➤ A PREDICTION that spontaneous disintegration of free neutrons into hydrogen atoms would be discovered was made to the British Association for the Advancement of Science meeting at Dundee, Scotland, by Dr. O. R. Frisch of Britain's Harwell Atomic Research Laboratory. Neutrons are the fundamental particles that set off the fission of atoms in the atomic bomb. Hydrogen in the form of the proton which is its heart is another fundamental bit of matter of the same weight.

Study of the way neutrons scatter from inorganic molecules will show the position of the hydrogen atoms within them, Dr. Frisch also predicted. This should be of eventual industrial importance.

Element Turns Into Another

➤ A NEW TWIN of one of the most recently discovered chemical elements turns into another rare element after existing only five minutes.

Prof. F. A. Paneth of Durham University called the attention of the International Chemical Congress to this new isotope of element 87. This

fundamental chemical building block was christened francium only this year by Mlle. Marguerite Perey of the Paris Radium Institute, who first discovered a radioactive isotope of element 87 with a half-life of 21 minutes.

The new isotope of 87 with a half period of five minutes emits alpha particles and changes into the element astatine, number 85.

The discovery of the new five-minute francium isotope will be reported in a scientific paper by Drs. A. C. English, T. E. Crawshaw and their collaborators in the *Physical Review*.

Extinct Elements Discovered

➤ A PREHISTORIC family of heavy radioactive elements which may have occurred naturally in the earth's beginnings but now is extinct was unearthed during development of the atomic bomb.

This missing link in the periodic table was found with production of synthetic elements neptunium, americium and uranium 233. It includes the recently identified elements 85 and 87, explaining fully for the first time the absence of these elements from nature.

Called the neptunium series because neptunium 237 is the longest-lived of the family, it is the missing one of our four series of disintegration products of the heavy radioactive elements. The others are the uranium, thorium and actinium series.

Two parallel investigations are reported in the *Physical Review*. One was headed by Dr. Glenn Seaborg, of the University of California, while he was at Chicago, with co-authors listed as Drs. French Hagemann, Leonard Katzin, of Argonne, Martin Studier, Chicago, and Albert Ghiorso, University of California. The second study was by Canada's Division of Atomic Energy.

One of the authors of the Canadian report was Dr. Alan Nunn May, who is now serving a 10-year sentence in Britain for revealing atomic research data to Soviet Russia. Other Canadian scientists reporting on the work were A. C. English, T. E. Cranshaw, P. Demers, J. A. Harvey, E. P. Hincks and J. V. Jelley.

The reason for the extinction of the newly-discovered series is the relatively short half-life of the parent, neptunium, which is two million years. The age of the earth is estimated at two billion years.

Neptunium, like other heavy radioactive elements, decays by alpha particles, until it reaches a stable isotope. It decays to uranium 233, the synthetic isotope made by bombardment of thorium, and then down through isotopes of radium, actinium, francium, astatine and polonium until it reaches stable bismuth 209. Americium, element No. 95, is an even more remote ancestor of the series with half-life only 500 years.

The other three series exist in nature because of the long half-lives of the parents, these being four and one half billion years for uranium 238, fourteen billion years for thorium 232 and seven hundred million years for uranium 235. The latter isotope was not known when the actinium series was named, but it is the actual parent.

"Nuclide" New Scientific Term

➤ SCIENTISTS have discovered so many new facts about the heart of the atom, the nucleus, that a new scientific term is needed, an atomic scientist suggests.

The new word for your atomic vocabulary is "nuclide." Truman P. Kohman of the Institute for Nuclear Studies of the University of Chicago proposes it in a communication to the editor of the *American Journal of Physics*.

Nuclide, he explains, comes from the word nucleus and a Greek word meaning species, sort or kind. Hence, nuclide means a species of nucleus.

One of several members of the proposed nuclide family would be the famous isotopes. Radioelement or radioisotope should now be called radionuclides, in most cases, declares the physicist.

A nuclide is defined as a species of atom characterized by the construction of its nucleus, particularly the number of positive electrical units and neutral particles in the nucleus of the atom.

Isotopes, under the new scheme, are nuclides with the same number of positive charges in the nucleus. Thus, they belong to the same element, though they have different atomic weights.

Other atomic nuclides are the isotone, isobar, isodiaphere and isomer. These are all chemical terms classifying atoms by the number of positive electrical units and neutral particles in the nucleus.

Unbalanced Equations

INS Puts the Atomic Energy Commission Out of Business!

U. S. Is Taking Terrific Loss On Radioisotopes

ST. LOUIS, Sept. 6 (INS).—Dr. Paul C. Aebersold, Oak Ridge, Tenn., disclosed today that Uncle Sam is taking a terrific loss on his sale of radioisotopes to needy nations fighting cancer.

He told the fourth International Cancer Research Congress in St. Louis that the U. S. Atomic Energy Commission is offering them at prices ranging from $1.10 to $52 each as compared with an estimated cost of one million dollars per unit when produced by a cyclotron.

Highlights of Chemical Advances Reported at Chemical Society Meeting

Chemists Changing the World

Gathering at New York City the week beginning September 15, members of the American Chemical Society reported on their researches. Interesting points at which chemical progress makes itself felt in daily life appear in the following stories from the meeting.

Queen Bee's Life Secret

➤ SOLOMON advised seekers after wisdom to go to the ant. Modern chemistry directs seekers after long life to go to her relative, the bee. Vitamins in royal jelly, the infant food on which the hive's queen-mother is reared, account for her extraordinarily long life expectancy — five years, as compared with the workers' three months—Dr. Thomas S. Gardner, industrial chemist of Nutley, N. J., told the American Chemical Society.

Four vitamins have been identified in royal jelly, Dr. Gardner stated. They are pantothenic acid, pyridoxin, sodium yeast nucleate and biotin. While each alone has more or less effect in prolonging insect life, their interactive effect when taken together seems to be much greater than the simple sum of their separate effects.

Chemists are still far from making Methusalehs out of ordinary, short-lived mortals by feeding them queen-bee pabulum. Dr. Gardner has departed from the royal nursery in the hive only to the extent of feeding various combinations of the four royal-jelly vitamins to fruit-flies, those special pets of geneticists. Greatest extension of the fruit-fly life-span thus far achieved has been 46%.

Aids Soil Conservation

➤ FLOOD-EROSION effects on soils can be prevented by radical chemical treatments that will give them greater clay-like tenacity and thereby increase their resistance to washing, it was suggested by Prof. Ernest A. Hauser of the Massachusetts Institute of Technology and Dr. D. S. LeBeau of the Midwest Rubber Reclaiming Company.

The treatments proposed would be aimed at the silica content of soils, which is their mineral backbone. The general idea is to increase the proportion of silica colloids, giving the soils firmer consistency and greater cohesiveness, or "stick-together power." The speakers also suggested the desirability of mixing fertilizers with clay before spreading, instead of applying them directly to the topsoil. This renders the nutrient salts more easily available to the plant roots, thereby making for greater economy in fertilizer use.

Metal-Strengthened Trees

➤ TREES internally strengthened with metal are not necessarily results of successful operations by tree surgeons; they are more often nutritional successes. J. F. Wischhusen of the Manganese Research and Development Foundation told the meeting of some

strange effects obtained by feeding fruit trees with the proper combinations of the so-called trace elements. Trees receiving manganese, cobalt, copper and iodine showed relatively little damage from frost. Trees deficient in manganese, copper, zinc and magnesium lost almost all their leaves and much of their fruit, and many of them showed severe limb splitting.

Synthetic Gasoline

➤ CHEMISTS and industrialists are foresighted enough to miss the gasoline before the oil-well runs dry, and the search for a successful, and above all a cheap, synthetic motor fuel goes intensively on. At a symposium on this subject, several speakers told of present researches and of hopes for the future.

Standard gases used in making synthetic gasoline by the German Fischer-Tropsch process are hydrogen and carbon monoxide. Classic method for producing them, already mixed, is to pass steam over or through glowing coke; but this, declared Dr. A. R. Powell of the Koppers Company, Pittsburgh, is not yet cheap enough to compete with petroleum. Efficiency must be increased, cost lowered, before American drivers can tell the pump man, "Fill 'er up with synthetic!"

Another process for producing the hydrogen-carbon monoxide mixture was described by H. S. Seeling and R. F. Marschner of the Standard Oil Company of Indiana. They have produced the mixture in 97% purity on a laboratory scale by passing hot methanol (wood alcohol) vapor through a stainless steel tube containing a copper-oxide-nickel catalyst.

A third process, described by R. E. Reitmeier and associates of the Girdler Corporation, Louisville, involves the use of steam, carbon dioxide, and either methane or propane, both of which occur in natural gas.

Dye Produced by Mold

➤ AN ORANGE DYE that may find industrial use has been found in a fungus that causes a disease in plants of the potato family, *Fusarium solani*, by Prof. F. F. Nord, S. Weiss and J. V. Fiore of Fordham University. The pigment is purple as it occurs in the mold and the crude extract, but when purified and made slightly acid it turns orange. It has been given the name Fusarium solani D_2.

The pigment also seems to have antibiotic, or penicillin-like properties for it has been found able to inhibit the growth of another, related fungus, *Fusarium lini*, which is the cause of the extremely destructive plant disease known as flax wilt.

New Slow Action Insulin

➤ A NEW SLOW action insulin for diabetes has been made by combining regular insulin with part of the blood's red color chemical. Method of preparing it was reported by Drs. Richard G. Roberts, Doris M. Hilker and Adrian Gasior-Russell of the Chicago Medical School at the meeting of the American Chemical Society.

Diabetics will only need one injection per day of this new insulin, instead of the two to four often required when plain insulin is used, the Chicago chemists predicted on the basis of tests with rabbits.

The blood chemical used to prolong insulin's action is hemin. It is part of the hemoglobin which gives blood its

red color and carries oxygen throughout the body. The fact that it comes from blood and is therefore not foreign to the body is said to give it an advantage over protamine, another chemical which has been combined with insulin to prolong its action.

Besides hemin from blood, the new insulin compound contains choline. This chemical, sometimes called a vitamin and sometimes a hormone, plays a role in the body's utilization of fat. Insulin controls sugar utilization. Choline, when given to diabetic patients with fatty livers, permits lowering their insulin dosage, according to the report to the society.

To Preserve Vitamins

➤ VEGETABLES' TROUBLES aren't necessarily over when they have been safely sealed up in tin cans and processed to kill all decay germs inside. To be sure, gross spoilage is extremely unlikely, but subtler forms of deterioration are still possible even with all the germs dead. What these are, and what to do about them, were discussed before the meeting of the American Chemical Society, in a joint paper by Dr. J. F. Feaster, M. D. Tompkins and W. E. Pearce, research chemists of the American Can Company.

At higher storage temperatures, spontaneous slow chemical changes take place in the compounds responsible for good flavor, the chemists stated. Certain of the vegetable vitamins are also liable to breakdown. Prevention is relatively simple: keep the canned goods at warehouse or home-shelf temperatures lower than 70 degrees Fahrenheit.

Packaging Cured Meats

➤ ARE YOU LIKELIER to buy ham if the meat is nice and pink or dried beef if the flesh is good and red? That is the reaction of the average purchaser, and is as it should be, for those are the normal colors of the muscular parts of properly cured meats, declared Drs. W. M. Urbain and J. M. Ramsbottom, research chemists for Swift and Co.

The compounds responsible for this attractive redness are nitric oxide derivatives of myoglobin, the two chemists stated. These are attacked by oxygen, causing undesirable color changes, in the presence of light. To keep the products in marketable condition, therefore, it is desirable to package them in such a way as to exclude either or both of these spoilage factors.

"Slower" Fertilizers

➤ CONVENTIONAL nitrate fertilizers used in agriculture are like cocktails: they give a quick pickup but are very soon gone. Reason for this is their high solubility; what the plant roots are not able to take at once will be leached down into the soil or washed away with the runoff water in the first few rainstorms.

Experiments with new, slow-soluble nitrate fertilizer called uraform, made by compounding urea and formaldehyde, were described in two papers presented by U. S. Department of Agriculture scientists working at the great federal experiment station at Beltsville, Md. This compound, chemically related to the familiar synthetic plastic, bakelite, yields its nitrogen slowly and keeps a reserve supply in the soil for a long time.

Participating in the first series of researches were Drs. K. G. Clark, J. Y. Yee, K. S. Love and F. O. Lundstrom.

The second paper, presented by Dr. N. W. Stuart, described soilless gardening experiments in which uraform was used with ground phosphate rock as the source of phosphorus, together with other essential mineral nutrients, in a synthetic "soil" consisting of the peculiar micaceous mineral known as vermiculite.

Predigested Vitamin A

➤ CHILDREN suffering from the rare but highly fatal disease known as cistic fibrosis of the pancreas may have their lives saved by a predigested form of vitamin A, Dr. A. B. McCoord and associates of the University of Rochester told the meeting. Young sufferers from this pancreatic ailment are unable to absorb vitamin A in their food. A predigested alcohol form of the vitamin, however, is readily taken up.

Alcohol from Cornstalks

➤ MIDWESTERNERS who can remember back to prohibition days do not need to be reminded what a potent alcoholic source cornstalk juice could be, as it seeped down to the bottom of the silo. Unless the hired man was zinc-lined, Monday morning was very apt to find him rubber-legged.

Now the same stuff, reformed and de-headached, has been presented as a possible source of industrial alcohol. Before the meeting of the American Chemical Society Herbert C. Gore of Scarsdale, N. Y., presented in detail the procedure whereby he has been able to make alcohol out of the juice of mature but still undried cornstalks. He obtained yields of 95% alcohol at rates of from 50 to 95 gallons per acre of cornstalks.

Paints from Milk Acid

➤ IF YOU WERE looking for paint and were told you could find it in the milk-can, your first reaction might well be to look about in alarm to see how you had strayed onto a lunatic asylum's farm.

But that would not necessarily be the case. Chemists learned from Dr. Paul D. Watson of the U. S. Department of Agriculture, of a whole series of tough, serviceable new paints produced from lactic acid, which is the stuff that makes sour milk sour. The acid, which can be produced in immense quantities from the whey that is a problem byproduct of the cheese industry, is polymerized and made into resins with fatty acids. These resins can be spread as paint-like films.

New Idea in Pigments

➤ A NEW IDEA in house-paint pigments was proposed by F. J. Williams and A. R. Pitrot of the National Lead Company. To get pigments that will keep their color longer and wear out more slowly, they prepare fine particles of silica, to which the monobasic sulfates and silicates of lead are chemically cemented. These present a defiant wearing surface to the weather.

Cheap Materials for Gas

➤ LOW GRADE COAL and lignite can be used as raw materials for synthetic gasoline without making use of costly pure oxygen, V. F. Parry and associates of the U. S. Bureau of Mines told the meeting. In their process, a double-walled retort is used, with the coal or lignite dumped into the space

between inner and outer walls and treated with steam as it slides down. Retort temperature is raised to 1,900 degrees Centigrade. The steam and hot coal react to form the mixture of hydrogen and carbon monoxide, known as synthesis gas, which is the basis of the standard process for making synthetic gasoline originally developed in Germany.

Atomic Energy May Locate Fossils

➤ ATOMIC ENERGY will be tested to obtain information concerning prehistoric man from certain limestone formations in South Africa. A University of California expedition outfitted in July will try out the method, the American Society of Mechanical Engineers was told by Robert Sibley of the university staff.

In these limestones, he said, are skulls and fossil remains that will have a great bearing in tracing the ancestry of man. It is expensive to dissolve out the limestone material to obtain them. If means could be found to photograph a piece of limestone so that any fossils in it could be known before expensive excavations are made, it would greatly facilitate the speed of this study and reduce the expense.

Experiments were conducted, before the expedition left for South Africa, using radioactive materials previously bombarded by the fast moving particles in the cyclotron. Means were found that will enable the scientists to acquire information on the fossils without ever having dissolved the enclosing media.

Petroleum Alleviates Fat Shortage

➤ NEW CHEMICAL developments in the petroleum industry play an important role in alleviating the world food shortage according to Dr. Gustav Egloff of Universal Oil Products Co., Chicago. One of the most critical products in this situation is fat. Soap and glycerine have also been in short supply for a long time because of the fat shortage. The petroleum industry has already done much for the soap shortage in the United States by the production of sulfonated hydrocarbon detergents. It can also produce soaps by oxidizing petroleum fractions to fatty acids. By next year the industry will be augmenting the glycerine supply, as processes have been developed for its production from propane and propylene. The commercial plant costing $7,000,000 will produce 35 million pounds yearly when completed. All of these processes conserve animal and vegetable fats for human consumption.

Petroleum can also supply raw materials for edible fats, by oxidizing paraffin wax to fatty acids which when combined with glycerine yield edible fat. The Germans added to their food supply by such a process during the war. Although butter is still preferred, the hungry peoples of the world, who receive none or very little fat, would doubtless appreciate such a product.

Calcium Cyanamide Kills Weeds Then Weathers Into Fertilizer

Beneficent Excess

Reprinted from "For Instance," American Cyanamid Company

▶ THE CHEMIST informs the farmer about the nature of his soils, the needs for fertilizer, and how to control pests and diseases. And in the case of calcium cyanamide he shows the farmer how to make one chemical do a variety of tricks, some of which seem contradictory until explained.

The original calcium cyanamide business was the supplying of a pulverized form to provide nitrogen and improve the condition in mixed fertilizers. In this it competes with ammonium sulphate, ammonium nitrate, and Chilean nitrates.

For a long time in this country only a little calcium cynamide was put directly on the soil by itself, but some crops require nitrogen only and the logic of its separate use is now well recognized in raising fruit, cotton, corn, sugar cane and truck crops and in improving grasslands.

In recent years new uses have been found for it. Like almost anything, it can be used to excess with temporary damage. A deliberate intensive overdose of calcium cyanamide on tobacco plant beds, it was found, kills weed seeds better than fire; then during 60 to 90 days it undergoes its usual gradual alteration in the soil, changing by biochemical action to urea, to ammonia and finally to nitrate nitrogen fertilizer. Thereafter tobacco seed can be sown in the sterilized beds and the plants reach the point of readiness for transplanting while the beds remain weed-free, at great savings over former costs for laborious hand weeding. Similar soil sterilization procedures are useful with other transplants—tomatoes, peppers, cabbages, etc. Light dustings of calcium cyanamide kill young weeds in asparagus beds without harm to the deeper-rooted crop.

Heavy calcium cyanamide applications—750 to 3,000 lbs. per acre—mixed into the soil one to three months before planting, control nematodes, pink rot of celery, club root and certain insect larvae. Subsequently the calcium cyanamide loses its lethal character, functioning thereafter simply as a generous supply of fertilizer and lime.

A new Experiment Station report now discloses methods of using calcium cyanamide intensively to sterilize composts prepared for top dressing the fine turfs of putting greens and tennis courts and for enriching seed beds and greenhouse soils. Grass clippings and garden refuse such as corn stalks and vines of tomatoes, peas and beans, accumulated in layers with sand and loam and given a year to decompose, make useful compost, always impaired, however, by the presence of live weed seeds. Some organic chemicals, tried for killing seeds, with the help of bacteria, fungi and moisture, generated heats up to 170° F but heat was found inefficient as a destroyer of

seed and sometimes caused loss of useful nitrogen. Admixture of 13 lbs. of granular calcium cyanamide per cubic yard, however, was found to be enough to kill all seed in the course of a few weeks storage; it accelerates the natural process of bacterial decay and, without heating up the compost, converts more of the cellulosic material to humus; also, of course, it contributes fertilizer nitrogen and useful residual lime and may thus make separate fertilization or liming unnecessary. No chemical "burning" of the turf follows application of such compost. This method has been verified under field conditions over a period of three years.

Diamonds Detect Atomic Radiation

➤ Diamonds can be used to detect and "count" the radiations of uranium and other radioactive materials.

This discovery, disclosed at the National Bureau of Standards, may give atomic scientists a new tool and offer a new type of alarm instrument to protect the lives of atomic workers from potentially deadly rays.

Bureau of Standards scientists said tests have shown that diamonds, size-for-size, are a thousand times more sensitive detectors of alpha, beta and gamma rays than any man-made counter. The Geiger-Mueller counter, frequently used to reveal atomic radiation, is considered one of the most sensitive of scientific instruments.

Diamonds used as counters in the same manner as the Geiger-Mueller counter have two big advantages over standard radiation counting instruments. Diamond counters could be used for a long time, compared with the three months to two years of use for standard equipment, and the diamond counters can be far smaller. Small size will permit diamond counters to be used inside the human body or in small openings in industrial equipment, scientists at the Bureau of Standards explained.

To detect and measure the radiation from radioactive materials, the diamonds must be colorless and "perfect." Only one diamond in 40 is estimated to qualify.

Diamond counters tested at the Bureau of Standards use standard counting apparatus with the diamond placed between two small brass electrodes. One electrode puts 1,000 volts of electricity across the diamond, while the other connects with the counting apparatus.

Rays from radioactive materials are counted by setting up an electrical pulse when they strike the counter. When a ray strikes a diamond, it knocks an electron off one of the atoms in the diamond molecule to set off the electrical pulse.

The structure of diamonds includes a large percentage of empty space for the pulse to be set up in. Though they are one of the hardest substances known, diamonds actually contain only .000000000000001% of matter, or atoms. Another advantage is that diamonds are crystals which have the atoms arranged in a regular pattern with paths for the electrons to follow.

New Antibiotics and Synthetics

➤ EXTRACTION of two anti-malarial chemicals, one of them 100 times as powerful as quinine, was announced by J. B. Koepfli, J. F. Mead and John A. Brockman, Jr., California Institute of Technology chemists, in a report to the *Journal of the American Chemical Society*.

The chemicals were obtained from the leaves and roots of a plant long known to the Chinese as having anti-malarial properties. In China, its roots are called Ch'ang Shan. Botanical name for the plant is *Dichroa febrifuga*.

Febrifugine and isofebrifugine are the names the chemists give the new antimalarials. The names, as well as the last name of the plant, come from two Latin words meaning fever-reducing. Febrifuge is an old medical term for any fever-reducing remedy.

Tested against malaria in ducks, febrifugine was about 100 times as active as quinine. Isofebrifugine has only slight activity against duck malaria.

The scientists are now exploring the possibility that the leaves of the plant may contain still another anti-malarial chemical.

Antibiotics from Mushrooms

➤ ANTIBIOTICS, or penicillin-like compounds, are found not only in soil molds but in their evolutionally higher relatives, the fleshy fungi or mushrooms. A survey by Dr. William J. Robbins and a group of co-workers at Columbia University and the New York Botanical Garden disclosed germ-stopping powers in 213 out of 332 species of mushrooms examined.

Now Dr. Robbins, with Dr. Frederick Kavanagh and Miss Annette Hervey, have made a more intensive study of two species of wild mushrooms cultivated in the laboratory, and have been able to isolate the antibiotic substances in them. From one species, *Pleurotus griseus*, they have obtained a substance which they have named pleurotin, and they suspect that the mushroom contains a second antibiotic, not yet isolated. Pleurotin is able to check growth of the boil germ, Staphylococcus, as well as the tuberculosis germ in laboratory vessels. Beyond determining that it is non-toxic to white mice in moderately heavy doses its possible medicinal value has not been explored.

The second mushroom species, *Polyporus biformis*, yielded two germ-stopping compounds which have been named biformin and biforminic acid. Biformin proved effective against the two test organisms, the germs of boils and of tuberculosis, in glass vessels. Addition of rabbit blood greatly reduced its activity, so that it was not surprising to find that it had no effects against the same germ species in the bodies of mice.

Details of the research are given in two reports published in the official journal of the National Academy of Sciences.

New Antibiotic from Soil

➤ WHOOPING COUGH, typhoid fever and other diseases untouched by penicillin may yield to a new disease remedy from germs, called aerosporin.

This new potential remedy comes from a bacterium found in the soil in Surrey and Yorkshire and also in the tap water in an American city, Chicago.

Discovery of aerosporin is reported by Drs. G. C. Ainsworth, Annie M. Brown and G. Brownlee of the Wellcome Physiological Research Laboratories, Beckenham, Kent, in the journal, *Nature*.

Aerosporin is extracted from the broth in which the bacterium grows by methods like those used for extracting streptomycin. Streptomycin also comes from an organism found in the soil, but its parent organism is more like a mold than a bacterium. And streptomycin has also been reported active against the germs of whooping cough and typhoid fever.

Aerosporin not only checks the germs but actually kills them, Dr. Ainsworth and associates report. Another advantage is that apparently disease germs will not grow resistant to it as they do to sulfa drugs, penicillin and streptomycin. At least, the Wellcome scientists were unable to make germs acquire resistance in test-tube experiments.

The new chemical is readily produced, relatively stable and weight for weight is as powerful against one class of disease germs as penicillin is against another.

Remedy for Filariasis

➤ A NEW, arsenic-containing chemical is now under trial as a remedy for filariasis in dogs and man. This worm-caused tropical disease caused great worry to many of our fighting men in the South Pacific because late, untreated stages of it develop into elephantiasis.

The new chemical is announced by Drs. G. F. Otto and T. H. Maren, of the Johns Hopkins Schools of Medicine and Hygiene and Public Health, in the journal, *Science*. It is known as Tropical Disease Center no. 970, has a 16-syllable chemical name and its simplest chemical description is substituted phenyl arsenoxide. It was first made in the scientists' laboratory and later by Parke, Davis and Co.

It is the first chemical ever discovered, so far as is known, that will kill all the grown-up worms of filariasis in doses that can be given to man. Filariasis has previously been treated with antimony compounds. These, however, only remove the baby or embryonic worms, called microfilariae, from the blood. It is the grown-up worms that are believed to be responsible for blocking the lymph channels and causing the grotesque and often horrible swellings of elephantiasis.

Chemical for Brucellosis

➤ PAB, a chemical that has been used with considerable success in ridding livestock of parasitic worms, has now been found to have a sulfa-like action against the exceedingly minute germs called Brucella, that cause contagious abortion in cattle and undulant fever in human beings. This new usefulness of an old drug was described by Drs. Cornelia M. Cotton and Robert E. Swope of the University of Maryland, before the meeting of the

American Veterinary Medical Association.

PAB, which is shorthand for para-aminobenzoic acid, was effective against the Brucella organism both in glass laboratory vessels and in the living bodies of animals. If too little of the drug was given, the germs were only stimulated and encouraged. But when the dose was increased, it at first checked their growth, then killed them outright. In some tests, PAB was first injected into the bodies of guinea pigs, followed by one and one-half billion virulent Brucella organisms. Even such a massive invasion of the germs was able to accomplish nothing; even at the end of five weeks no trace of them could be found in the animals' bodies.

Unlike some germ-stopping drugs, PAB seems to produce little toxic effect on the animals under treatment, even when they continue to receive the drug for several weeks.

Sulfa Drugs Help Turkeys

➤ SODIUM SULFAMERAZINE, one of the sulfa series of germ-stopping drugs, was found an effective remedy for turkeys having the usually highly fatal fowl cholera, Dr. J. O. Alberts of the University of Illinois reported. The drug was given to 30 out of 40 tom turkeys afflicted with this malady, while ten were left untreated, as controls. The treated 30 survived, the untreated 10 all died. When new outbreaks of the disease occurred later, the sulfamerazine treatment promptly stopped losses.

Sulfathiazole, another compound in the sulfa series, was reported beneficial to chickens suffering from fowl cholera by Dr. H. M. DeVolt of the University of Maryland. One per cent of the drug mixed in with their mash at feeding time seemed to be the optimum dose; less than that proved insufficient and more was apparently unnecessary. Moreover, if as much as two per cent were given it made some of the birds sick.

Sulfathiazole was a good preventive, too, when given 48 hours before the chickens were deliberately inoculated with the disease. It took 128 times as big a dose of germs to produce a fatal infection in chickens thus protected, as compared with unmedicated birds.

Anesthetic for Horses

➤ A MIXTURE of old-fashioned knock-out drops (chloral hydrate), Epsom salt and pentobarbital sodium has had good results as a total anesthetic for horses, bulls and other large animals that need surgical attention but might suddenly send the veterinary himself to the hospital in the midst of the operation. Dr. E. W. Millenbruck of Carthage, Mo., described this new aid to the veterinary surgeon, which he developed jointly with Dr. M. H. Wallinga of Cedar Rapids, Iowa.

The mixture is safe and non-poisonous, said Dr. Millenbruck. It produces a short but complete period of anesthesia, enabling the surgeon to work undisturbed. The animals recover from its effect quickly and without the floundering that might cause them further injury. He stated that he has used it in animal surgery that without it would have been difficult for him and painful to the animals.

For the Home Lab

Hi-Ho, Silver!

by BURTON L. HAWK

➤ SILVER has been known and sought after for many centuries and was once considered more valuable than gold. Today gold is more valuable, but silver is far more useful. It is the best conductor of heat and electricity known and is one of the most malleable and ductile of all metals. Alloys of silver are used extensively to make coins, jewelry, tableware, etc.

The Metal

It is possible to obtain silver in the pure state from an alloy by chemical means in a fascinating home experiment. Place 10 cc. of dilute nitric acid in a flask and add a dime or a quarter, depending on your financial status. Heat the flask gently until the entire coin is dissolved, being careful not to inhale the brown fumes. The solution is colored blue by the copper in the coin, and consists primarily of copper nitrate and silver nitrate. Add an equal quantity of water, mix thoroughly and pour one-half of the mixture in an evaporating dish. Save the other half of the solution for use later on.

If you will refer to the electrochemical series of the metals, you will note that silver is near the bottom of the list. Now the chemistry textbook tells us that any metal in this list will displace a metal that lies below it from solution. The most logical metal for us to use would be copper; if we used any metal above copper, copper itself would be displaced along with silver.

Electrochemical Series of Common Metals

1. Potassium
2. Sodium
3. Calcium
4. Magnesium
5. Aluminum
6. Zinc
7. Iron
8. Tin
9. Lead
10. HYDROGEN
11. Copper
12. Mercury
13. Silver
14. Gold

Take a copper coin and clean it thoroughly by rubbing with a dilute solution of acetic acid or vinegar. (This experiment is runing into money!) Place the clean coin in the solution in the evaporating dish and let stand for a while.

Mercury is above silver in the electrochemical series and it can also be used to displace silver. This time, use a solution of pure silver nitrate. Add a small globule of mercury and let it stand. Soon you notice crystals of silver "growing" on the mercury.

Now let us go back to our copper coin. By this time sparkling white

crystals of silver tinted blue by the solution will have formed. Remove the coin carefully; wash and dry the crystals. If you wish to obtain a coherent mass of silver, you can do so by melting the crystals. Silver melts at 960°. If you have difficulty in reaching this temperature, we suggest you try using a blowpipe. Place a few crystals in a small shallow container, such as a porcelain crucible lid. Grasp the lid with crucible tongs and point the flame from the blowpipe directly upon the crystals. Then blow, brother blow! Create a steady flame, keeping your cheeks inflated. Finally when you are just about ready to give up, the mass will lose shape and a shimmering white liquid of molten silver will form. Pouring this into a large container of water will produce small white balls of pure silver.

Its Compounds

When the Creator assembled this world of ours from some 92 odd substances, He imparted to the compounds of silver a rather unique property—sensitivity to light! For hundreds of years man used metallic silver, never realizing that the compounds of this metal were as valuable as the metal itself. For upon this seemingly unimportant property the entire photographic industry depends!

You can demonstrate the action of light upon silver compounds in a striking manner. To the second half of the dissolved coin solution prepared earlier, add a solution of sodium chloride. A thick, white precipitate of silver chloride forms. Filter and wash the precipitate thoroughly with water. Next open the filter paper flat and spread the precipitate evenly over it. Lay a hard object, such as a coin, key or nail on the surface of the silver chloride. Now ignite about 2 or 3 inches of magnesium ribbon and hold it directly above the object. After exposure to this brilliant light, the white compound will gradualy darken, passing through various shades of pink, red and violet. If the object is now carefully removed, its image will remain as a white design imbedded in violet. Wherever light does not reach, the silver compound remains white.

If sodium hydroxide be added to silver nitrate solution, the brown muddy precipitate of silver oxide is formed. (The hydroxide of silver is not stable.) If this oxide is filtered off and heated, it rapidly decomposes leaving a residue of metallic silver. Silver oxide combined with organic protein preparation forms the well-known antiseptic, *Argyrol*.

The compounds of silver are varied in color. Add a little silver nitrate solution to solutions of potassium iodide (pale yellow); sodium sulfide (black); potassium chromate (brick-red); sodium phosphate (tan); and potassium ferricyanide (orange).

Silver nitrate is used in medicine as an antiseptic and germicide. Which reminds us of the story of Mrs. Van Rich. She brought her son to the doctor who advised that he would treat the ailment with nitrate of silver.

"Oh, Doctor," pleaded Mrs. Van Rich, "please use nitrate of gold. Expense is no matter."

Chemical Attacks on Many Fronts Speed War Against Dread Disease

Chemicals Against Cancer

by JANE STAFFORD

➤ WORLD cancer experts meeting in St. Louis in September heard about hope for cancer conquests in:

Radioactive cocktails for leukemia.

Gold, iodine and phosphorus created as atomic bomb byproducts.

New kinds of war gases.

Male hormones for female cancers, and vice versa.

Brain operations and new drugs for banishing pain.

X-rays, radium, surgery, early diagnosis, and other older methods of attacking cancer, world's most dreaded disease, received major attention as the experts gathered for the first international cancer congress in eight years. The fight on cancer was slowed during the war, but notable progress nevertheless has been made.

The war itself speeded some of this progress. Development of man's most destructive military weapon, the atom bomb, made available radioactive chemicals for cancer-fighting on a vast scale. In the Clinton laboratories at Oak Ridge, Tenn., where hearts of atoms were torn apart to make the bomb, atoms are being peacefully disrupted to make radioactive gold, iodine and phosphorus for cancer treatment, and radioactive carbon and other elements for study of malignant disease.

Cocktails of radioactive sodium phosphate were first used to treat leukemia, cancer-like disease of the blood, in 1939, the year the International Cancer Research Congress last met. In that same year, treatment of cancer patients with neutron rays from the cyclotron was begun. These advances were widely heralded but the number of patients who could be helped by the new sources of cancer-killing radiation was infinitesimal because the material all had to come from cyclotrons. These atom-smashers, few in number, were at that time the world's only sources of man-made radioactive material. Now such materials in greater numbers and larger quantities are being produced in the atomic pile at Oak Ridge.

For the war, also, chemists developed new kinds of mustard gas, the nitrogen mustards. These are now showing promise in the war on cancer and other malignant diseases, though they are so new that their full benefits and true place in cancer-fighting may not be known until this congress meets again.

Chemical remedies like the sulfa drugs and the mold chemicals penicillin and streptomycin, born just before and during the war, triumphed over wound infections and hosts of other disease germs. Chemical remedies for cancer are being sought intensively in many laboratories. Podophyllin, chemical from the Mayapple and an old remedy used by American

Indians, is one of the latest being tested.

New chemicals for the relief of pain in late cancer have been discovered within the past eight years. These are metopon and amidone. A brain operation, devised originally for mental sickness, has within this past year been turned to banishing the pain of cancer patients.

Hormones, which are chemicals produced by the body's glands, are now being used to fight cancer. One of the most significant advances in this field is the discovery that castration or doses of female hormone will help men suffering from prostate gland cancer. Soon after that discovery, doctors began applying it in reverse, using male hormone to treat advanced and spreading breast cancer in women.

Breast cancer in mice has been traced to a substance, believed to be a virus, in mouse mother's milk and the virus has been isolated. Benefit of this to humans will come from further study of the material and its method of action.

In Russia human cancer patients are being treated, with encouraging results, with material popularly termed KR serum. The letters are the initials of the husband-wife team, Drs. Gregory Roskin and Nina Klyueva. The material is actually an endotoxin obtained from the blood plasma of mice that have in their bodies the germs of Chagas' disease. American scientists are now trying to produce and study the same material. Its place in cancer treatment is still a matter for the future to determine.

Treatment by standard methods, surgery, X-rays and radium, has made strides since the last meeting of this congress. Statistics showing a continued decline in cancer deaths among women and even a slight downward trend in cancer mortality for men were noted during the year 1946 in the United States.

Earlier diagnosis is helping to fight cancer. Part of this has come from greater awareness of cancer signs and symptoms on the part of the public. Part has come from new tests for cancer, such as the one that detects the disease from cells shed from the cancer as it grows. Cancers of the uterus, stomach, kidneys and bladder are being detected by this means.

Development of a three-million-volt X-ray machine for treating deep-seated cancers, and a concentrated method of giving radiation treatment for resistant cancer of mouth, larynx and pharynx have been developed within the past eight years.

Surgeons have gained greater skill and do not hesitate to remove an entire lung or all the stomach to save a patient from cancer of those organs.

Two Blood Tests

➤ TWO BLOOD TESTS for cancer announced at the International Cancer Congress promise to lead to the long-sought goal of a test to diagnose cancer in its early, curable but too often unsuspected stages.

One of them even now is suggested as a "valuable screening agent," mean-

ing that it might be used to separate cancer from non-cancer patients somewhat as X-rays are used to screen TB patients from non-tuberculous patients in a community.

This screening agent test was devised by Dr. Maurice Black of the Brooklyn Cancer Institute and New York Medical College. It is made with two dyes, brilliant cresyl blue and methylene blue. A little of the dye is added to a little blood plasma in a test tube and the tube put in boiling water. If the patient has cancer the brilliant cresyl blue, at the end of ten minutes, will have turned to lavender and the plasma and dye will form a clot. If the patient does not have cancer, this clot will be grayish-white. The methylene blue is completely decolorized in less than ten minutes if the patient does not have cancer. If he has cancer, it takes his blood plasma more than ten minutes to decolor the dye.

In 681 cases the test had an accuracy of 86%. It was 100% accurate in normal patients, 92% accurate in patients sick of other diseases than cancer, 83% accurate in harmless tumors, and 80% accurate in cancer.

The second blood test was devised by Dr. Louis Herly of Columbia University, New York. It is made with ultraviolet light. Normal blood serum seen under filtered ultraviolet is turbid and glows with fluorescence. Blood from animals and humans with cancer fails to glow and is clear. When the cancer has been removed by surgery, the blood serum is again turbid and glowing under the ultraviolet light. When the cancer has been treated by X-rays, radium or nitrogen mustard, the serum has a murky, bluish color under the ultraviolet light.

In animals, when cancer cells are injected into their bodies, the cancer that develops cannot be seen until five days later. But their blood serum shows the presence of cancer by this ultraviolet test within 20 to 43 hours.

Dr. Herly developed this test as a result of earlier work that started with using ultraviolet light to trace the course of fluorescent cancer-causing chemicals through the body of rats as cancer developed.

Another dye that glows under ultraviolet light may help detect cancer tissue for the surgeon to remove. At present, bits of cancer that have invaded and become hidden by normal tissue may be missed at operation.

Trials of this method in 46 patients were reported by Dr. George E. Moore, National Institute of Health fellow at the University of Minnesota Medical School. His report appeared in the journal, *Science*.

Best results were obtained when the dye, sodium fluorescein, was injected into the patient's vein three to eight hours before operation. During the operation, when the surgeon has reached the point where the patient's stomach, for example, can be seen, he inspects the area with an ultraviolet lamp. Cancer tissue glows with a vivid yellow color, showing the surgeon where to cut to remove it.

Good results were obtained in 31 of the 46 cases. Most of the nine failures occurred in attempts to fluoresce large, bulky tumors within the abdomen. Cancers of the lower intestine, stomach and breast were found less likely to fluoresce.

This might be due to insufficient amount of the dye or insufficient time between its injection and the ultraviolet inspection.

The most consistent results were obtained in examination of brain tumors. A bit of tissue from suspected areas was sucked out with a needle and readily recognized by its exaggerated fluorescence under the light.

The use of radioactive iodine is now being considered for aid in distinguishing between cancerous and non-cancerous tissue at operation. Certain mouse tumors could be seen better by X-ray when iodine was substituted in the dye, which suggested putting the radioactive form of iodine into the dye.

How Cancer Kills

▶ Discovery of a clue to the unsolved mystery of why cancer kills was announced by Drs. G. B. Mider, H. Tesluk and J. J. Morton of the University of Rochester School of Medicine at the International Cancer Congress.

The clue is that in mice, and probably in humans, the cancer acts as a nitrogen trap. Nitrogen is an essential chemical for all protein tissue in the body. Muscle is the most familiar but by no means the only such protein tissue. The body gets this nitrogen from protein foods, such as meat, milk and eggs. But the cancer may take more of this than the diet provides.

It robs the body of its stores of nitrogen, and it holds this trapped, so that the rest of the body cannot use it. With its nitrogen gone, the body dies.

This theory, based on studies in mice, would explain why patients with cancer, especially in the last stages, lose weight and get very thin. Rats with cancer lose about 30% to 40% of their carcass weight, that is, of the weight of the body exclusive of the weight of the cancer.

As the cancer grows larger, the demands for nitrogen exceed the supply from the diet. The cancer gets the chemical at the expense of the body. Death comes when the body tissues cannot supply further nitrogen.

The situation is "like a motor which must supply power to machines," Dr. Mider explained. "The motor works well at its rated horsepower. It can function efficiently with some excess load. But if the load continues to increase, the motor will fail. The motor will also fail if its own source of energy is seriously impaired."

So far the findings apply only to one kind of cancer in mice under one set of experimental conditions. More studies are needed to confirm the theory and extend it to cover cancer in man. But scientists hearing the report believe it may explain many things about human cancer not now known.

For example, patients sometimes live for many years with cancer in their bodies before it finally kills them. Doctors are seeing more and and more of such cases, now that surgery and X-ray have become more efficient in eradicating the primary

cancer. Deaths are more frequent now from cancers that have spread from the original one.

At first these spread cancers, called metastases, give no sign of their existence. It may be years before they grow to the point of killing the patient. If these spread cancers were ordinary scar tissue scattered widely through the body, the patients would be alive and well.

Some ways in which cancer kills are already known. It may kill by interfering with the function of a vital organ or by causing hemorrhage or ulcers which get infected and then the patient dies of the infection. But injury and other non-cancerous conditions may kill by the same means. The killing effect of cancer itself is not understood unless the nitrogen trapping action explains it.

Soft-Shelled Body Cells

➤ HARD-SHELLED cells are linked with aging of the body. Soft-shelled body cells are linked with cancer. Calcium, the mineral that makes bones and teeth hard, and an unknown chemical in the cell that binds calcium to itself and the cell make the difference between aging, hard-shelled cells and young, vigorously growing cells of youth and cancer.

This, briefly, is the picture of cancer and the aging process evolved by Dr. Albert I. Lansing of Washington University of St. Louis and Barnard Free Skin and Cancer Hospital.

The theory is based on studies by himself and numerous other investigators, he pointed out in a report to the journal, *Science*.

The stopping of growth is a critical turning point in the starting of age changes, Dr. Lansing found in studies of rotifers, microscopic worms that live in stagnant water.

Successive generations of these worms were traced. Lines of old parentage showed a progressive decline in mean life span. All became extinct after a limited number of generations. Lines of parental age younger than that at which growth ceases showed progressively longer life spans and are free of any age change.

The length of life of rotifers could be markedly increased by treatment with sodium citrate which removed calcium from their cells, Dr. Lansing found in other experiments.

Cancer tissue is markedly low in calcium, scientists have repeatedly shown. A calcium deficiency in cancer cells has recently been reported as the reason for a decreased stickiness of the cells. The decreased stickiness makes separation of one cancer cell from another easy and may be part of the reason for the spread of cancer through the body.

These findings on cancer are what could be expected if little calcium in cells is a mark of young, vigorous growth.

Chemical Attacks

➤ A SYNTHETIC substitute for vitamin K, the anti-bleeding vitamin, is being tried as a weapon against cancer.

No curative value is claimed by

the Cambridge University scientists, Prof. J. S. Mitchell and Mrs. I. Simon-Reuss, in their report to the journal, *Nature*.

But, they report, the vitamin K substitute checked the division of cancer cells. The division process, known as mitosis, is that by which more cancer cells are produced and the cancer grows.

When X-ray treatments were given after the vitamin had been injected into the muscles daily for several weeks, the effect on cancer cell division was even more pronounced. Bits of tissue from a cancer on the floor of the mouth were examined under the microscope. After the synthetic vitamin K substitute treatment there was a "highly significant reduction" in the frequency of cancer cell division. This would indicate that the cancer's growth was being checked.

X-ray treatments were then given and after that it was impossible to count the dividing cells in a bit of the cancer tissue because all the cancer cells were grossly degenerate. Similar checking of cell division was observed in chick embryos.

The synthetic vitamin substitute had no toxic or ill effect on the 25 patients to whom it was given, showing that it would be safe to use if it proves effective.

The anti-bleeding action of vitamin K was first discovered in relation to chickens. It has since been used to save new-born babies and sick grown-ups who were in danger of bleeding to death in certain kinds of jaundice and liver disease.

Improvement in 28 of 58 cancer, Hodgkin's disease and acute leukemia patients has been obtained with a new and fundamental chemical attack on cancer reported by Dr. Maurice Black of New York at the International Cancer Congress.

The improvement unfortunately does not last more than a few months. But Dr. Black hopes that by continuing on his present line of attack he can find a way to outwit the cancer permanently.

The treatment consists in giving chemicals which block the cancer's mechanism for producing energy from food chemicals. This mechanism is different in cancer cells than in normal cells. The first two chemicals used to block this mechanism in the cancer are sodium fluoride and iodoacetic acid. Within three weeks, the patient begins to get better. The cancer, or in Hodgkin's disease the enlarged glands, shrink but after two of three months, the patient relapses. This is because the cancer has found a new way to run its energy-producing mechanism. A third chemical, malonic acid, is then given. This stops the cancer, but only for a time. Then Dr. Black gives a fourth chemical, sodium azide. This may make the patient worse temporarily, because it lets the cancer go back to its original energy mechanism. But at that point, the sodium fluoride and iodoacetic acid can be started again and will again be effective for a few months.

A carrier chemical which will bind the cancer-stopping chemicals to the cancer cell and thus prevent the cancer from adapting to them is now sought. When and if this can be found, it may provide a way to chemical cures of cancer, acute leukemia and Hodgkin's disease.

Elements Familiar to Chemists Behave Strangely in Other Worlds

Chemical Advances in the Heavens

Helium and calcium vapors are familiar to astronomical chemists, but have been determined in new places. New discoveries locate solid iron in one star's atmosphere and clouds of neutrons in another's.

➤ A GIANT red star deeply enveloped within an iron curtain has had its mystery pierced by an American astronomer, after seven years of ceaseless watching.

The star is Antares, that glows redly in the southern constellation Scorpio; it is sometimes called "heart of the scorpion." It really consists of two stars, a giant red member 450 times the diameter of the sun, and a much smaller, terrifically hot, blue globe that seems to consist mainly of helium.

The astronomer is Dr. Otto Struve, who is director of two observatories: the Yerkes observatory of the University of Chicago and the McDonald Observatory of the University of Texas on Mt. Locke, Texas. Since 1940 he has been waiting for the perfect atmospheric conditions that would permit him to separate the light from the two close companions on his spectrographic plates.

When he finally did get this astronomer's dream of a perfect night, his plates showed an unexpected and astonishing result: Both red and blue members are at the heart of an enormous cloud of iron particles that has ten times the diameter of our solar system. Furthermore, their light indicates that the iron is not in gaseous form, but exists as extremely minute solid particles, resembling the meteors or shooting stars familiar nightly in the earth's upper atmosphere.

Flaming Prominences On Stars

➤ STARS, as well as our sun, have great flaming prominences and flares of hot gas extending from them that make any earthly storms or volcanoes feeble by comparison.

This discovery was reported to the American Astronomical Society by the same astronomer.

Dr. Struve's observations were made on the unusual eclipsing binary star UX Monocerotis. His work throws new light upon the origin of gaseous streams, rings and shells which exist in many close double-star systems and in some peculiar single stars.

UX Monocerotis consists of a large, fairly massive star of the same type as the sun, although much larger, and a hotter star of less mass. These stars revolve around each other at speeds of 37 and 87 miles per second, respectively. There is a total eclipse when the solar-type star hides the smaller, other one. During this eclipse clouds of calcium gas are observed spectroscopically expanding

outward from the solar-type star at a velocity of 155 miles per second.

But the hotter star also gives out prominence clouds, principally of observable hydrogen gas. The sun's own prominences, which are visible during a total eclipse of the sun as bright red tongues of "flame," are composed principally of hydrogen, but also contain large amounts of the same calcium gas observed in the case of UX Monocerotis.

Frequently observed gaseous streams and rings in other eclipsing variable stars owe their origin to a similar process, Dr. Struve said, explaining it is probable that all of these tenuous formations are being replenished by prominences from one or both stars. He expects that prominence action is also responsible for the formation of rings in rapidly rotating single stars.

Dr. Struve suggested that the enormously extended atmospheres of supergiants, such as Deneb (alpha Cygni), may also be caused by a vast field of prominences. He credited Dr. Donald H. Menzel, of Harvard, with arriving at substantially the same conclusion by an entirely different process of reasoning.

New Measure of Starlight

▶ Astronomers have an improved method for learning details about faint stars, on which even the most powerful telescopes bring only vague information. The method, called photoelectric photometry, enables scientists to measure weak light intensities with unprecedented accuracy.

Dr. Gerald E. Kron, assistant astronomer in the University of California's Lick Observatory and a leader in developing the improved technique, says photoelectric photometry permits operation of the 36-inch refractor as effectively as a 100-inch instrument could be operated by usual methods.

With this refracting telescope Dr. Kron has observed stars of the fourteenth magnitude, and stars of the sixteenth magnitude are within reach. The brightest stars observable with the 36-inch instrument by previous methods have been of the tenth magnitude.

Photoelectric photometry was pioneered in this country by Dr. Joel Stebbins of Washburn Observatory, the University of Wisconsin. Dr. Kron's refinement of the technique depends primarily upon the invention, just before the war, of an efficient electron multiplier.

Light gathered in a telescope lens from a star is made to fall upon a photosensitive surface, which is in effect a photocell. The electrons emitted from this surface are amplified by the electron multiplier. The instruments are so sensitive that a few hundred electrons per second can be measured.

Dr. Kron has already applied the technique to the study of stellar atmospheres, and has verified a unique theory of Harvard astronomers about the make-up of the atmosphere of one of the rare Wolf-Rayet type stars.

The Wolf-Rayet stars are unusual primarily because of their thick at-

mospheres and because they are two-star planetary systems, the stars eclipsing each other twice in each revolution.

Because of these eclipses the light coming from these stars is constantly changing. Dr. Kron's systematic studies of a Wolf-Rayet star through several revolutions disclosed that the thick atmosphere absorbs light independently of its wavelength, unlike the differential absorption with wavelength by the gaseous atmosphere of the earth.

Dr. Kron says that the peculiar behavior of light emanating from these stars can be explained on the basis of the theory propounded by the Harvard astronomers that the atmosphere of the Wolf-Rayet stars is made up of a cloud of electrons. He has also found that many stars which appear to have a uniform brightness over the whole surface actually have decreasing brightness toward the edges.

Aside from bringing out new fundamental facts, photoelectric photometry greatly speeds up astronomical research in problems where it can be used. In ten seconds Dr. Kron took a reading on a fourteenth magnitude nebula which ordinarily would have taken about 10 minutes to record on a photographic plate.

Several lifetimes of new research have been opened up as a result of the application of the refined photoelectric photometric technique to astronomy, Dr. Kron says.

Nitromethane, High Explosive

➤ NITROMETHANE, high explosive much more powerful than TNT but much safer to handle, is now released from military restrictions and is available for civilian use, Harold Shechter of Purdue University announced at the meeting of the American Chemical Society. Mr. Shechter's colleagues in research leading to the cheaper and more efficient production of this useful detonating compound were H. B. Hass, L. G. Alexander and D. B. Hatcher.

Nitromethane, as its name implies, is the nitrated form of methane, which constitutes about 85% of most natural gas, and which, under the names of firedamp and marsh gas, has long been known as a peril in some coal mines. It is not at all new, having been first made in 1872; but production methods hitherto in use have not been efficient, and have used substances more expensive than methane, so that it has not been widely used where costs have to be counted. Mr. Shechter and his associates, treating methane with nitric acid under a pressure of 100 pounds per square inch, were able to obtain a very satisfactory yield.

Since natural gas costs only three cents a thousand cubic feet in Texas, and since many wartime plants built for the production of nitric acid are now standing idle, there is no good reason why nitromethane should not be turned out in any needed quantity at relatively low cost, Mr. Shechter pointed out.

Natural vs. Artificial, Gas Fuel Use Increases

For the Front Burner

Reprinted from the Industrial Bulletin of Arthur D. Little, Inc.

➤ Gas is becoming an increasingly popular fuel as well as an important raw material for chemicals. A survey in early 1946 showed that 52 per cent of new homes would be gas heated, compared with only 11 per cent of all homes existing in 1940. In Texas, dozens of new chemical plants are, or soon will be, converting natural gas to chemicals for solvents, anti-freeze, plastics, rayon, fertilizer, and other products. Two new plants in the Southwest will make gasoline, Diesel fuel, and chemicals from natural gas.

To help supply these needs, new natural gas deposits are being found —last year reserves showed a net increase of 13 trillion cubic feet to a total of 160 trillion, despite withdrawals of 5 trillion—and pipeline systems are being built to carry the gas thousands of miles from the Southwestern fields to population centers. Manufactured gas, usually made from coal or coke near the point of use, is also receiving attention. New methods of production may result in economies; one company in Alabama is experimenting with the conversion of coal to gas underground to avoid the expense of mining and handling solid coal. The trend is toward less production of gas by the distributing utilities and more purchasing from large central producers. Natural-gas companies are the most important source now, but coal companies may sometime gasify coal at the mine and ship the gas by pipeline to the cities.

Natural gas is already a much more important source of heat than manufactured gas, and projected pipelines will introduce it to many new consumers. After new compressors are installed, the Big Inch and Little Inch pipelines will deliver 150 billion cubic feet of natural gas annually to the East. Pipeline construction projects approved in the first year after the war will add 4500 miles to the 61,000 miles of main gas transmission lines previously existing, and an annual throughput of 400 billion cubic feet. One of these new lines will run from Texas to Southern California and another to Detroit, Milwaukee, and cities along the route. Transporting gas for 1500 miles through a pipeline such as the Big Inch costs about 21c per thousand cubic feet; gas at the well-head costs only about 5c, a potent reason for establishing chemical conversion plants in the Southwest. Natural gas has high heating value, about 1000 British Thermal Units (B.t.u.) per cubic foot, hence it can be more economically transported than manufactured gas, with a typical heating value between 500 and 600 for the type used domestically. Most natural gas is used industrially, but even so, more natural than manufactured gas is used domestically, since houses are

commonly heated with natural gas where it is available.

Underground gasification of coal, suggested several years ago, and already employed in Russia on a commercial scale, does not yet offer a solution to the difficulties of mining. Generally, a U-shaped tunnel is dug into the deposit of coal, with two openings at the outcrop of the seam. A fire is started in the interior of the shaft and air is blown in one of the openings. Incomplete combustion of the coal, as well as expulsion of some volatile materials, produces a gas which is collected at the other opening. The direction of flow is periodically reversed for uniform burning within the mine. The air may be alternated with steam and enriched with oxygen to increase the heating value of the gas.

Several variations of this procedure have been attempted in Russia since 1933, leading to the first commercial installation in 1940. The experiments have been plagued by cave-ins, combustion of the gas in the mine, seepage of gas to the atmosphere, and other difficulties. A particular problem has been formation of large pockets as the coal is consumed. Here the air can mix with the gas and burn it before it can leave the mine. The Lyubertsy Station near Moscow has, however, produced a gas of 124 B.t.u. heating value, using air containing 25 to 30 per cent oxygen. Two other large-scale stations were closed by the war. The Russians report that output per man can be increased from 30 tons per month to the equivalent of 100 to 120 tons per month by underground gasification. In U. S. mines, which are more highly mechanized, a man produces about 120 tons in a month of 6-day weeks, and in some the output is over 300 tons.

An experiment recently completed by the Alabama Power Co. and the Bureau of Mines involved the underground gasification of 800 tons of coal in a block 150 feet long by 40 feet wide. When a straight steam run followed a period of air blasting, gas with a heating value as high as 240 B.t.u. per cubic foot was produced. With use of oxygen and steam, the heating value may possibly be stepped up to an estimated 300 B.t.u. per cubic foot.

Because of the low quality of gas produced underground, gasification on the surface is projected for the $3,00,000 pilot plant of the Standard Oil Co. (N. J.) and the Pittsburgh Consolidation Coal Co. at Library, Pa. Powdered coal from nearby mines will be "fluidized" to react with a stream of oxygen and steam to produce "synthesis gas," which may be converted to gasoline and other liquid fuels by the Fischer-Tropsch process. The possible ultimate outcome of this experiment will be a $120 million plant to produce 400 million cubic feet of gas from 20,000 tons of coal daily. In winter, when the demand for gasoline falls off, the synthesis reaction might be modified to produce more gas for domestic heating; in summer, gasoline would be produced at a maximum rate of about 14,000 barrels a day.

Australian rabbits, long a destructive pest, are now heavy contributors to the country's food supply.

Inventions in Chemical Fields

To get a copy of the complete specification, send 25 cents (not stamps) for each patent, and order by number, from the U. S. Commissioner of Patents, Washington 25, D. C.

➤ CHEMICAL ELEMENTS that used to be merely symbols on a classroom chart are one by one being drafted into industrial uses. Beryllium alloys are becoming familiar on the tool-bench; suburban gardeners push wheelbarrows and lawnmowers made largely of magnesium; uranium dominates the turbid politics of a shuddering planet.

Germanium, an element something like silicon, discovered only two generations ago, now claims its place in the sun of science. Quite literally: its usefulness is in a new optical glass developed by a Chinese-born chemist in the research laboratories of the Eastman Kodak Company at Rochester, N. Y., Dr. Kuan-Han Sun. He has substituted germanium oxide for its familiar chemical analog silica (sand), in a formula including also titanium oxide and sodium fluoride, to obtain a glass with high refractive index, that should be especially useful in wide-angle camera lenses and microscope objectives.

Since current market price for germanium oxide is between $30 and $40 an ounce, immediate use is likely to be limited to special lenses. U. S. patent 2,425,403 has been issued on the new fluogermanate glass.

Thorium Separation

➤ ONE OF THE most widely known of British chemists, Dr. Frederick Soddy, retired Oxford University professor, has received patent 2,425,573 on an improved method for extracting thorium from minerals containing it.

Thorium is another element with an unfamiliar-looking name; actually, however, it was a household article not so long ago. Its oxide was the stuff gas mantles were made of. It is still used in ceramics and other industries, and is a definite possibility in the development of atomic energy.

Basically, Dr. Soddy's method consists in using less sulfuric acid than customary in getting the thorium out of the phosphatic minerals, and in exploiting the phosphoric acid thus released in the separation of cerium and other rare-earth elements from the thorium.

H From Wood Alcohol and H_2O

➤ THE ABUNDANT and industrially important gas hydrogen can be made cheaply from methanol (wood alcohol) and water by a process on which patent 2,425,625 has been granted to a du Pont chemist, Dr. Alfred T. Larson of Wilmington, Del.

Methanol, which has the formula CH_3OH, can be cracked by an already known process to yield two molecules of hydrogen and one of carbon monoxide. Dr. Larson simply adds water, in the form of steam, in the presence of a catalyst. The oxy-

gen from the water goes to convert the carbon monoxide to the dioxide, releasing one more molecule of hydrogen. The carbon dioxide is readily removed, leaving pure hydrogen to be "bottled" for use.

Pepper Insecticide

➤ DDT, 666 and some of the other new synthetic insecticides may presently have competition from a modernization of an old-fashioned discourager of insects, black pepper. Edward Harvill, chemist on the staff of the Boyce Thompson Institute for Plant Research at Yonkers, N. Y., combines piperine, extracted from pepper with alcohol, with pyrethrin, to make a highly potent insecticide. A one-tenth per cent solution made a 99.8 per cent kill of flies in one test, he states. His patent number is 2,425,530.

Tames TNT, PETN

➤ WITH AN UNEASY, divided world anxiously keeping its powder dry, more than ordinary interest attaches to a new method for making rifle powder on which U. S. patent 2,425,854 has been granted to Harvey B. Alexander of Kenvil, N. J. It produces a propellant in which violent explosives like TNT and PETN, formerly thought suitable only for bursting charges in projectiles, can safely be used for boosting bullet speeds to higher levels.

The trick lies in finely pulverizing the high explosive to be used, and embedding each of its tiny grains (about .003 inch diameter) in a pellet of the more deliberately-burning ordinary smokeless powder. This sets off thousands of small bursts of high energy behind the bullet, without the development of uneven or dangerously high pressure in the weapon's bore. Propellants of this type have been tried out with good results in both military and sporting cartridges.

Favored high explosive for this purpose is PETN, or pentaerythritol tetranitrate. Unmixed, this has such sudden, violent action that when it was used during the war in bazooka rocket heads it had to be blended with TNT to slow it down a bit.

Rights in the patent are assigned to the Hercules Powder Company.

Movies of Interference

➤ THE LIGHT-AND-DARK bands that result when two crossing beams of light of the same wavelength catch each other on the half-beat, so to speak, are used today in exact industrial measurements as well as in pure science. They are the ultimate gauges, the final arbiters when lengths must be determined to millionths of millimeters. A National Bureau of Standards research man, James B. Saunders of Alexandria, Va., has devised apparatus with which shifts in these bands can be recorded continuously on motion picture film. Patent 2,425,758, issued on this, is assigned royalty-free to the government.

Another Hydrogen Source

➤ HYDROGEN, the gas of ten thousand uses, is made by reacting methane or other hydrocarbons with steam in the presence of a catalyst. For a method of doing this with the catalyst particles juggled aloft instead of lying in lumps, patent 2,425,754 has been granted to four Standard Oil researchers, E. V. Murphree, C. W. Tyson, D. L. Campbell and H. Z. Martin, who have assigned their rights to the Standard Catalytic Company.

HF Recovery

▶ Two patents, Nos. 2,425,745 and 2,425,752, both assigned to the Phillips Petroleum Company, cover different processes for recovering the dangerous but useful hydrofluoric acid after employment as a catalyst in oil refining. The first, issued to A. B. Leonard and G. R. Hettick, contacts with a low-boiling hydrocarbon the acid that might escape as a waste, then re-cycles the mixture through the towers. The second, taken out by Mr. Hettick with G. E. McKenna, involves condensation and separation from organic impurities.

Natural Gas Will Make Gasoline

▶ Natural gas of the low-heating-value type, now regarded as unsuitable for sale as fuel, is to be used in the manufacture of gasoline and oil.

The plans as yet are tentative. They contemplate the use of the products of the huge Hugoton gas field of southwestern Kansas, claimed to be the largest gas field in the United States and to contain reserves of 23,000,000,000,000 cubic feet. The Stanolind Oil and Gas Company of Tulsa, Oklahoma, is proposing to construct a plant in this field that will process about 100,000,000 cubic feet of gas daily.

In the engineering plans now well completed, an extensive pipe line gathering system and a natural gasoline plant would be installed to provide the necessary volume of dry feed gas. In the process the feed gas is burned under 300 pounds pressure with relatively pure oxygen to yield synthesis gas with a composition controlled to within narrow limits.

For every 15,000 cubic feet of gas charged to the plant, it is expected that one barrel of crude synthetic oil would be obtained. Also there would be produced alcohols, ketones, aldehydes, acids and other oxygenated compounds. The recovery and treatment of the hydrocarbon products for market would be by conventional methods.

One step of the process to be employed is based on the German Fischer-Tropsch synthesis principle. In this a gaseous mixture of carbon monoxide and hydrogen is passed over a catalyst under suitable conditions of temperature and pressure to yield hydrocarbons in the liquid fuel range. In Germany, coal was used as the raw material for preparing carbon monoxide and hydrogen.

Gasoline and other hydrocarbons from natural gas have been made in pilot plants and will soon be available in quantities from a commercial plant in Texas. However, this establishment will use natural gas of fuel value it is understood, not the low-heating-value gas proposed in the new Kansas plant. A method developed by the Kellogg Company of Jersey City produces gasoline at a cost competitive with natural petroleum. The new Kansas plant will produce it also at a competitive cost. The U. S. Bureau of Mines, from its own research, states gasoline can be obtained from natural gas at from 5.5 to 7.0 cents a gallon, and from coal and oil shale for from 7.5 to 9.5 cents.

Analysis Locates Mineral Deposits

► CHEMISTRY is now playing an important part in helping locate hidden minerals in the earth. In the relatively new process, surface waters and certain parts of plants are analyzed to determine mineral compounds within them. The results indicate the chemical composition of underlying ore bodies.

The process is known as the chemical or biogeochemical method. It was described in a recent issue of *Mining and Metallurgy,* a publication of the American Institute of Mining and Metallurgical Engineers, by Kalervo Rankama of the geology department of the University of Chicago. He described also the detection of mineral ores by the existence of indicator plants. This is the geobotanical method.

These methods, he stated, may provide geologists with far more information on the chemical composition of ore bodies and provide a more direct method for prospecting and locating ore bodies of specific metals than have the detailed examination of surface rocks and the results of various geophysical methods.

Principles behind the methods are simple. All minerals are soluble in water to some extent, he said. Ground water passing an ore body will dissolve the minerals in the ore. Consequently, the elements present in the ore body can be detected in the overlying soil, or in vegetation.

Copper-nickel ore in central Finland was located by Mr. Rankama by spectrographic analysis of the ashes of birch leaves growing in the vicinity. A distinct enrichment of nickel, he stated, was found present in plants growing in the immediate vicinity of the outcropping copper-nickel ore body in the northern area near Petsamo, formerly a part of Finland but now Russian territory.

Also, there are certain plants that grow best in the vicinity of certain mineral elements in the soil. Several ore deposits, discovered because of the presence of one or another of these plants, were mentioned by him.

Advice on Home Cleaning

► IF YOU MUST try to remove stains at home, here are a few hints to follow. Carbon tetrachloride is probably the most effective aid in removing paints, oils and fats. A stain containing sugar can best be removed by using water or other wet solvent. Should you spill a soft drink, beer, tea or fresh fruit, sponge the suit with clear water—never use soap.

A mixture of 20% glycerine and 80% water may be used in removing a coffee stain. If cooking oil or animal fat is spilled on a coat or dress, apply carbon tetrachloride, tamping with a cloth pad, rinse thoroughly in dry-cleaning solvent to remove the ring, and allow to dry. Never use milk in an attempt to remove an ink stain. In many instances the milk may be more difficult to remove than the ink.

▶ A STRUGGLE *over nothing is going on here, for the lads and their admiring audience are learning how much force is needed to pull apart the halves of the vacuum ball. Science is fun to these young members of Science Clubs of America.*

Science Can Be Fun

▶ EAGER TO TRY new things, "to see what will happen," the bubbling energy of teen age youth finds a natural outlet in scientific experiments. This fall, as school organizations are welcoming new members, a third of a million members of Science Clubs of America are resuming hobby activities that fit in with their high school studies.

In more than 14,000 junior and senior high schools there are these science clubs, each with a couple of dozen members who have as their guide and sponsor a favorite science teacher.

There are such clubs in your locality. Science Service is cooperating with school officials and scientists throughout the nation in providing

the information and know-how for science club organization and activities. Any teacher or interested adult who sponsors a science club can, without any cost whatever, affiliate it with the national Science Clubs of America and receive a hundred-page handbook full of data and aids to science hobby activities.

The young science enthusiasts have fun in carrying out their science projects. But what they do is very far from mere child's play.

Leading science organizations, in government, industry and elsewhere, cooperate in suggested projects. Many of the investigative tasks are of direct, practical benefit to the communities in which the science club members live.

The professional scientists and teachers also help this youth movement in science. State science academies, universities, colleges, teacher associations, museums and other organizations are cooperating.

State and regional science fairs or congresses for science club members are being held throughout the nation. The projects that are most noteworthy in the judgment of the schools are sent to these larger exhibitions where they often win scholarships and other prizes for the young scientists who did them.

Each year Science Clubs of America conducts the national Science Talent Search which culminates in the award of the Westinghouse Science Scholarships at the Science Talent Institute at Washington. This is a crowning activity of the science clubs and in many cases the seniors who participate have been working on their science hobbies during the whole six years of their junior and senior high school work.

Girls as well as boys are members of the science clubs. Most of the activities can be carried on as effectively by girls as by boys. In the Science Talent Search each year the proportion of girls who win honors is determined by the ratio of girls to boys who enter.

"I have wanted to be a scientist ever since I can remember," writes a Science Talent Search winner from her first job, as a lab assistant, "I feel I really play only an infinitesimal part in the glorious progress of modern chemistry, but I do enjoy being in on the ground floor. I can hardly wait until I can begin graduate work and really be on my own."

The science club activities of high school students have won approval from national and science leaders as a serious and important aid to the nation's science program.

America finished the war with a realization that there were not nearly enough scientists and development engineers available to discover new basic knowledge, do the necessary industrial and military research and train the oncoming scientific generation.

The report of the President's Scientific Research Board recommends that by 1957 the nation should devote at least one per cent of our national income to research and development in the universities, industry and the government. This means that many thousands of scientists and engineers will be needed in addition to the number that will be trained in colleges and universities if the number, normal in past years, are produced.

▶ "ADD TO THE *solution in the flask. . . .*" *Experiments are fun, too. At the senior high school level, boys and girls in science clubs conduct real research programs in cooperation with scientific organizations, both government and private, on a nation-wide scale.*

Many of the science club members in the schools of the nation this fall are receiving their first contact with science and its possibilities. The extent to which they and their teachers develop science club opportunities will determine to a large degree how well the urgent national need for scientists will be answered in the future.

For every club member who will become a professional scientist there are hundreds who will not. For most of the school science hobbyists, science will remain a hobby throughout life, remembered as one of the richest experiences of their youth. They will be better equipped to live in a scientific world and control the results of science so that civilization will progress rather than be wiped out.

Anyone interested in science clubs can get information by writing to Science Service, 1719 N St., N. W., Washington 6, D. C.

New Chemical Treatments Stop Wrinkles and Shrinkage

Cloth From Test Tubes

by A. C. MONAHAN

➤ DAINTY SUMMER DRESSES need no longer muss; seersucker suits may remain fresh and presentable. Pleats in skirts and creases in trousers will seldom need renewal in the steam pressing shop. And summer woolens will be cool and never shrink.

Chemistry is the answer. Textile chemists have been busy during the past decade. New treatments, which give cloth longer life without altering the general appearance, add many other desirable qualities.

They made them shrink-proof, water-proof, wrinkle-proof, rot-proof, distasteful to moths and mildew, and resistant to flame and stain.

The war is not responsible entirely for the new cloth treatments, but it did hasten the development of some of the new chemicals used, and their applications. American clothing on soldiers and sailors went abroad from frigid Baffin Bay to torrid New Guinea, to meet every known climatic condition in the world.

Special treatment of cloth for clothing, tents and other uses was essential to give them lasting qualities. Special weaves helped make some cloth warmer and others cooler. Water-proofing gave added comfort in all regions. Rot-proofing and mildew-proofing were important in the tropics. Flame-proofing aided fighting men wherever they were.

During war years, military needs held priority of the new materials. Now, however, they have been improved, adapted to general uses, and are available to the civilian population.

Traditionally, cloth and looms are always associated. Textiles are woven fabrics. Also traditionally, all cloth is made from natural fiber obtained from plants or animals. Textile fiber is now being made artificially from nonfibrous material in coal, corncobs, soybeans, peanuts, milk, woodpulp, and even from sand converted chemically into glass in the form of very fine, but not transparent, fiber.

These synthetic fibers can be woven on a loom. A new process, however, makes the loom unnecessary. The fibers are laid close together, side by side and crosswise, and bonded with a resin, heat-treatment and pressure between rollers.

There are also cloths, or sheeting, made without fibers. The well-known Cellophane is an example. They are made of plastic materials, some more or less rubber-like, spread in thin sheets and subjected to a curing process. The familiar nylon used as a fiber in women's stockings and other garments can be used also in a non-fiber form.

The present so-called "plastics age" holds no threat over fiber growers and textile manufacturers. Someone must grow much of the materials used to make plastics. But there will always

➤ CINDERELLA *has come a long way. With her little glass slippers she now wears both gown and jewelry of the same lustrous, fire-proof material.*

▶ His suit *wasn't proofed against anything, and look what a sudden shower did to it! This needn't happen when modern manufacturers apply their treatments to modern clothing materials.*

be a demand for woven goods. In fact the best uses for some of the new materials are in treating textiles. The plastic best suited for making sheeting is finding one of its principal uses as a coating over woven cloth. Another use is in the plastic film field.

In the film field, the usual plastic used is either vinyl chloride or some of its close relatives. In the fabric coating field, the older materials, such as nitrocellulose, rubber, oils and alkyds, are being supplemented with vinyl resins. Vinyl chloride and its so-called copolymers make up the bulk of these coating materials. Vinyl butyral forms a coating over cloth that is practically invisible.

Whether made of natural or synthetic fiber, woven or bonded, most cloths can be treated or so made that they have many desirable properties unknown in fabric of the past. Unshrinkable shirts and collars, and dresses that do not catch afire easily will add to comfort on one hand and safety on the other. Combustible clothing, accidentally touching a gas flame, has caused the death of many children.

Among the new fiber-treating materials is one with Resloom for a trade name, made by Monsanto Chemical Company. This synthetic chemical is relatively new but already has been well tested. Rayon goods treated with it are on the market. Cotton and woolens will follow. Exhaustive tests on both have now been made.

One of its principal abilities is to decrease shrinkage, even of woolens, to a negligible amount. When treated with Resloom, wool shrinkage is only

about 3% as compared with the usual 25% to 50% of the same fabrics untreated. In addition it stabilizes the wool so that extremely thin cloth suitable for summer all-wool garments can be woven.

Resloom is a resin known chemically as melamine formaldehyde. When wool, cotton or rayon is treated with it, the chemical enters the heart of the fiber and remains there for the life of the cloth. The basic fiber is not injured. Goods treated may be washed or dry-cleaned and ironed as usual. Resloom can be used with known water-repellents, fire-retardants and anti-mildew agents. The Resloom itself prevents mussing and gives the long-life crease in men's trousers.

Aerotex Cream 450 is the trade name of a product of the American Cyanamid Company. One of the chief resins used for spun rayon and rayon mixtures. it is a popular resin for crease-proofing linens as well as certain cotton fabrics, particularly voiles. It is a water-soluble, partially condensed, urea formaldehyde resin in paste form. Because of the small size of its molecules it can penetrate the textile fiber. A curing process fixes it within the fiber cells.

When applied to certain fabrics under the minimum of tension, shrinkage control is also obtained. When used in combination with another resin made by the same company, permanent water repellence and anti-crease finish are obtained in one bath.

Rot-proof cotton cloth is something new in the textile field. It is not a quality particularly essential in the clothing field but, being mildew-proof as well, is suitable for garments to wear in hot countries. Its greatest value is in cloth that is in contact with the ground, but also in tents, awnings and bags for fruits and vegetables.

This rot-proof cotton is a development of the United States Department of Agriculture in its research laboratory at New Orleans. It is a modified cotton, a partially acetylated cotton somewhat related to rayon made by the acetate process. In tests it failed to rot during six months under ground in soil where ordinary cotton would rot in a week or two.

Not all of the new chemically or otherwise treated fabrics are designed for clothing. Some are treated to assure longer life when used in upholstery or to provide beauty and safety from fire hazards when used as draperies. Flame-resistant fabrics are essential in night clubs and other public places where people assemble.

Other fabrics are treated for easy cleaning. A new table cover which resembles ordinary linen, can be kept clean on the table by wiping with a damp rag. Still others are waterproof sheeting for hospital and other uses. These can be made into raincoats and capes, and into protecting panties for baby.

Then, there is a gold- or silver-colored fabric that has many decorative uses in the home although designed for use in public places. It is a metal-coated plastic fabric that has a mirror-like finish. Its trade name is Miromesh, and it is made by the National Research Corporation.

The base material in this fabric is a mesh that resembles wire screening with the spaces filled with a cellulose acetate film. The fiber of the mesh is

a well-known plastic called Saran, a compound of polyvinylidene chloride, which is highly resistant to most chemicals.

The mesh, filled with the acetate, is coated on one side with a thin film of aluminum applied by a high-vacuum process. This is covered with a protective lacquer. Over the silver-finish, it is a clear lacquer; a gold-colored lacquer is used for the gold finish.

Beautiful draperies that defy fire, made by Plymouth Fire-Guard Fabrics, are woven of a combination of very fine glass fiber and flame-proofed cotton yarn. They are designed particularly for use in public places but are suitable in homes. They come in a wide range of colors and can be dry-cleaned, cut, sewed and ironed as easily as all-cotton materials.

In the future, the buyer of clothing will have to go further than the looks and the feel of the fabric. He will have to take the manufacturer's word for the invisible substances contained and, until tested, his word for the special qualities added to the cloth.

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